selectively transmit one or more predetermined spectral bands of light, and said optical system configured to image light within each predetermined spectral band onto particular portions of said image sensor; and

an image processing system for processing images from said optical system and providing a control signal for controlling the high beam state of the headlamps as a function of the output of one or more pixels within one of said portions relative to the output of other pixels within the same portion.

95. (Amended) The control system as recited in Claim 94, wherein said image processing system provides a control signal for controlling the high beam state of the headlamps as a function of the output of pixels within one of said portions relative to the output of pixels within another one of said portions and where each of said pixels within one portion images substantially the same region of space as a corresponding pixel within the other portion.

96. (Amended) The control system recited in Claim 95, wherein said optical system contains two or more filters to transmit a predetermined spectral band of light and each filter being configured to image said field of view onto different designated portions of said image sensor.

97. (Amended) The control system recited in Claim 96, wherein the optical system is configured to prevent light passing through one of said filters from arriving onto the portion of the image sensor designated for light imaged by another of said two or more filters.

REMARKS

The amendments and remarks presented herein are believed to be fully responsive to the Office Action mailed October 24, 2001. Enclosed herewith is a petition and fee for a one month extension of time in order to extend the response due date to February 24, 2002. Because February 24, 2002 is a Sunday, this Response is timely filed on Monday, February 25, 2002.

Claims 54-99 remain pending in the application. Claims 54, 68, 69, 71-74, 77-79, 82, 84-86, 89, 91, 92 and 94-97 have been amended herein. Claims 54, 71, 72, 74, 77-79,

82, 84-86, 89, 94 and 95 have been amended to refer to "headlamps" or "taillights" to be consistent with each other. The amendments are to clarify these terms and do not narrow the scope of these claims. The amendments are fully supported in the specification and drawings as originally filed. No new matter has been added.

The specification has been amended to correct a typographical error recently discovered in the application. No new matter has been added by this amendment.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

CLAIM REJECTIONS

Claims 54-99, particularly, claims 54, 68, 72, 74, 89, 94, 96 and 99, were rejected under 35 U.S.C. §112, first paragraph, as containing subject matter not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors had possession of the invention at the time the application was filed. Applicants respectfully traverse the rejection of claims 54-99. However, in order to expedite prosecution of the present application, and without acquiescing in the rejection in any way, Applicants have clarified claims 54, 68, 72, 74, 89, 94 and 96 without prejudice.

With respect to the rejection of independent claim 54, Applicants have clarified claim 54 to clarify that the imaging processing system provides a control signal for controlling the state of the headlamps as a function of the output of pixels imaging the same spectral band of light. Applicants respectfully submit that there is complete support for claim 54 in the specification and drawings. More particularly, Applicants submit that the limitation of controlling the state of the headlamps as a function of the output of pixels imaging the same spectral band of light is at least supported at page 10, lines 19-20 and page 14, lines 7-24. For example, at page 10, lines 19-20, the specification states that red light sources may be detected "only by looking at the intensity of 'red' pixels". This clearly discloses that the present invention is operable to control the state of the headlamps as a function of pixels imaging the same spectral band of light.

Further, Applicants respectfully traverse the Examiner's assertion that there is no support for the limitation "as a function of the relative output of pixels imaging the same band of light." To the contrary, Applicants respectfully submit that the specification, such as at page 14, lines 7-24, clearly sets forth that the present invention may relate the output of adjacent pixels or pixel groups imaging the same spectral band of light to determine the size, pattern, location and/or movement of the detected light source, in order to determine if the detected light source is a light source of interest, such as a headlamp or taillight. Particularly, if the light source is a red light source, the present invention may be operable to compare "red" pixels to determine the size, pattern, location and/or movement of the light source, such as discussed on page 14, lines 7-24. This is accomplished by considering "not only whether a particular pixel, or pixel group, is detecting a light source having a particular spectral signature, but also what adjacent, or closely related, pixels or pixel groups are detecting." See page 14, lines 8-10. The specification thus clearly discloses that the imaging processing system of the present invention may be operable to control the state of the headlamps as a function of the relative output of pixels imaging the same spectral band of light. However, in order to expedite prosecution of the present application, Applicants have clarified claim 54, without acquiescing in the rejection of claim 54 in any way, such that claim 54 is now in condition for allowance.

Therefore, Applicants respectfully submit that the control system of the present invention, particularly as set forth in claim 54, is clearly supported in the specification and drawings as originally filed, and is operable to control the state of the headlamps as a function of the output of pixels imaging the same spectral band of light, such that the rejection of claim 54 should be withdrawn. Reconsideration of claim 54 is respectfully requested.

Applicants have also clarified claim 68 to clarify that the image processing system includes at least two photosensor arrays and that the optical system includes at least two lenses, wherein one of the lenses is configured to image onto one of the photosensor arrays and the other of the lenses is configured to image onto the other of the photosensor arrays. This is fully supported in the specification as originally filed, such as at page 11, lines

13-23 and Figure 6. Applicants have amended claims 69, 71 and 73 to correspond with the above amendment of claim 68. Reconsideration of these claims is respectfully requested.

Applicants have also clarified claim 72 to clarify that taillights are detected by comparing the relative output of at least one pixel imaged through the red filter with the output of a selected group of neighboring pixels and indicating a taillight detection when the output of the at least one pixel is a predetermined percentage higher than the output of the selected group of pixels. Applicants respectfully submit that claim 72 is fully supported in the specification and drawings as originally filed. As discussed above, the specification, at page 10, lines 19-20, and page 14, lines 7-24, discloses that the control may be operable in response to a comparison of the relative output of red pixels. Also, the specification states that taillights may be determined when a red pixel is greater than a given multiple of green and blue pixels. See page 10, lines 13-20. The specification thus discloses that the control system may be operable to detect taillights by comparing the relative output of red pixels and determining when the output of the red pixel or pixels is a predetermined multiple or percentage higher than the output of a selected group of neighboring pixels. Therefore, Applicants respectfully submit that claim 72, as amended above, is fully supported in the specification and drawings as originally filed.

Applicants have also clarified claim 74 to clarify that headlamps are detected by comparing the relative output of at least one pixel imaged through a cyan filter with the output of a selected group of pixels, and indicating a headlamp when the output of the at least one pixel imaged through the cyan filter is a predetermined percentage higher than the output of the selected group of pixels. Applicants respectfully submit that claim 74, as amended, is fully supported in the specification as originally filed at least at page 11, lines 3-8 and at page 14, lines 8-15. For example, as set forth on page 11, lines 3-6, a white light source may be detected by determining the value of a red complement (e.g. cyan) pixel. The specification, at page 14, lines 8-15, further states that a headlamp may be identified by comparing a detected light source with other pixel groups, in order to confirm that the light source is a headlamp and not a streetlight or other light source. Therefore, Applicants respectfully submit that claim 74, as amended above, is fully supported in the specification and drawings as originally filed.

Therefore, Applicants respectfully submit that independent claim 54 and the claims depending therefrom, namely, claims 55-88, including amended claims 68, 69 and 71-74, are fully supported in the specification and drawings as originally filed and are in condition for allowance. Reconsideration of claims 54-88 is respectfully requested.

Applicants have also clarified independent claim 89 to clarify that the optical system includes at least two photosensor arrays and at least two lenses, wherein each of the at least two lenses is configured to image the predetermined field of view onto a respective one of the at least two photosensor arrays. Applicants respectfully submit that claim 89, as amended above, is fully supported in the specification and drawings as originally filed. The present invention is operable to image different spectral bands of the field of view onto different portions or different pixels or groups of pixels of the photosensor arrays, such as via a spectral filter array, such as disclosed at page 7, lines 14-19 and at page 11, lines 14-30. Furthermore, as discussed above, Applicants respectfully submit that the specification as originally filed discloses that the headlamps may be controlled as a function of the relative output of the pixels at least at page 10, lines 13-19; page 11, lines 1-7; and page 14, lines 8-10. Therefore, the specification fully supports a control system for processing images from the optical system and providing a control signal for controlling the headlamps as a function of the relative output of pixels imaging the external sources of light, particularly as set forth in claim 89.

Applicants have amended claims 91 and 92 to correspond with the above clarification of claim 89. Therefore, Applicants respectfully submit that independent claim 89, as amended above, and the claims depending therefrom are fully supported by the specification and drawings as originally filed and are now in condition for allowance. Reconsideration of claims 89-93 is respectfully requested.

Applicants have also clarified independent claim 94 to clarify that the optical system is configured to image light within each predetermined spectral band onto particular portions of the image sensor, and that the image processing system provides a control signal for controlling the high beam state of the headlamps as a function of the output of one or

more pixels within one of the portions relative to the output of other pixels within the same portion. Applicants respectfully submit that claim 94, as clarified above, is fully supported in the specification and drawings as originally filed. For example, the specification as originally filed discloses that the optical system is configured to image light within predetermined spectral bands onto different portions or pixels or groups of pixels of the image sensor at least at page 7, lines 15-19. More particularly, the optical system may include "alternating spectrum filter elements for exposing adjacent pixels to different regions of the electromagnetic spectrum." Page 7, lines 16-17. Applicants submit that light within each of the predetermined spectral bands or regions of the electromagnetic spectrum may be imaged onto a respective particular portion of the image sensor.

Applicants further submit that the specification as originally filed discloses that the high beam state of the headlamps may be controlled as a function of the output of some of the pixels of one portion relative to the output of other pixels of the same portion at least at page 10, lines 13-19; at page 11, lines 1-7; and at page 14, lines 8-10. For example, the specification states at page 14, lines 8-10, that a light source may be identified by detecting a light source having a particular spectral signature and determining what the adjacent, or closely related, pixels or pixel groups, are detecting. The closely related pixels may receive light within the same spectral band, such as in cases where the system is analyzing a red light source to determine if it is a taillight. Also, the specification, such as at page 14, lines 16-24, discloses that pattern recognition may also be used, whereby, for example, red pixels indicating a red light source may be compared to other red pixels (i.e. other pixels within the same particular portion of the image sensor) to determine if the relative location or pattern of the red light sources is consistent with taillights of a vehicle.

Therefore, Applicants respectfully submit that the specification clearly discloses that the headlamps may be controlled as a function of the output of one or more pixels within one of the portions of the image sensor relative to the output of other pixels within the same portion, such that claim 94 is fully supported by the specification and drawings as originally filed. Applicants have amended claim 95 to correspond with the amendment of claim 94.

Applicants have also clarified claim 96 to clarify that the optical system includes two or more filters to transmit a predetermined spectral band of light, with each filter being configured to image the field of view onto different designated portions of the image sensor. This is clearly supported in the specification as originally filed, such as at page 7, lines 14-19, and/or page 10, lines 23-30. For example, filter elements may be arranged in stripes or filter spectral regions may be alternated to expose certain pixels to one spectral band and other pixels or portions of the image sensor to another spectral band. Therefore, Applicants respectfully submit that claim 96, as clarified above, is fully supported by the specification and drawings as originally filed. Claim 97 has also been amended to correspond to the above amendments of claims 94-96.

Therefore, Applicants respectfully submit that independent claim 94, as amended above, and claims 96-98 depending therefrom, including amended claims 95-97, are fully supported by the specification and drawings as originally filed and are now in condition for allowance. Reconsideration of claims 94-98 is respectfully requested.

With respect to independent claim 99, Applicants respectfully submit that the specification and drawings as originally filed clearly disclose an optical system which is configured to not image light in the infrared region of the spectrum emitted by the light sources, thereby increasing the distinction between the red-emitting sources and the white-emitting sources. For example, the specification states that "spectral filtering is carried out in a manner which exposes each photosensing element in the photosensor array to a band of light falling within one of the primary ranges of the visible spectrum, namely red, green, or blue as illustrated in Fig. 8a." Specification, page 10, lines 23-25 (emphasis added). This is clearly shown in Figure 8a, reproduced below, where only visible ranges of light are passed through the filters to the imaging array. As shown in Figure 8a, the ranges of light being imaged include blue, green and red regions of the spectrum, where the red region includes light having wavelengths between approximately 540 and 700 nanometers, which is within the visible range of the spectrum, while the near infrared region of light, which is not imaged by the embodiment shown in Figure 8a, corresponds to light having wavelengths of greater than approximately 770 nanometers. Applicants respectfully submit that exposing the image array sensor to bands of light in the visible spectrum only, as set forth on page 10, lines 23-25

and as clearly shown in Figure 8a below, is fully supportive of the limitation of not imaging light in the infrared region of the spectrum, particularly as set forth in claim 99 as originally filed.

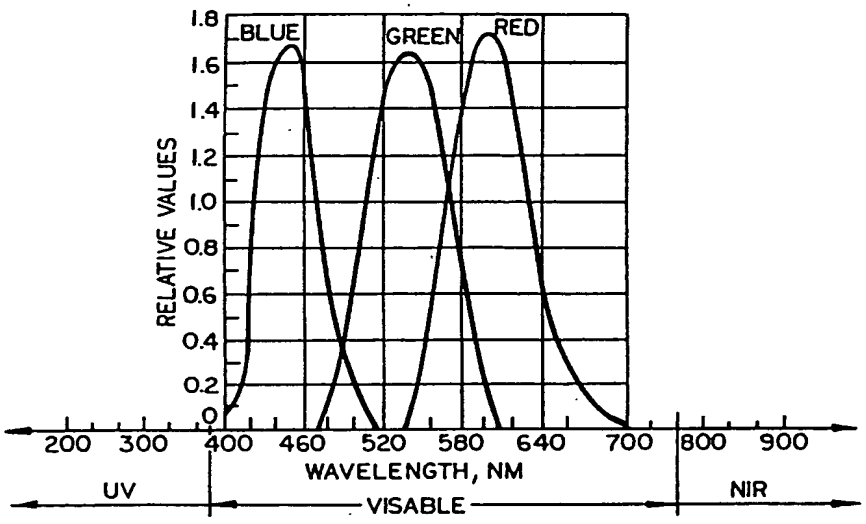

FIG. 8a

However, the Office Action states that the present application does not support the limitation of not imaging light in the infrared region because Figure 8c and the description on page 10 suggest imaging light in the infrared range. Applicants respectfully traverse this assertion and submit that Figure 8c does not depict imaging light in the infrared range. Furthermore, the specification on page 10 at lines 26-27 and Figures 8b and 8c refer to an alternate filtering approaches, some of which may image near infrared light. However, regardless of what is shown in Figures 8b and 8c, Applicants submit that Figure 8a (above) clearly shows not imaging light in the infrared region or near infrared region and thus clearly supports the limitation of claim 99. As discussed above, the embodiment shown in Figure 8a images only visible spectrum bands and, thus, does not image invisible spectrum bands, such as light in the infrared region of the spectrum, emitted by the light sources.

Therefore, Applicants respectfully submit that claim 99 is fully supported by the specification and drawings as originally filed, such that the rejection of claim 99 should be withdrawn. Reconsideration of claim 99 is respectfully requested.

Claims 54-99 are pending in the application. Claims 54, 68, 69, 71-74, 77-79, 82, 84-86, 89, 91, 92 and 94-97 have been amended herein. Applicants respectfully submit that all of the claims pending in this application are now in condition for allowance and notice to that effect is earnestly and respectfully requested.

Respectfully submitted,

KENNETH SCHOFIELD ET AL.

By: Van Dyke, Gardner, Linn & Burkhart, LLP

Date: February 25, 2002.

Timothy A. Flory
Registration No. 42 540
2851 Charlevoix Drive, S.E., Suite 207
Post Office Box 888695
Grand Rapids, Michigan 49588-8695
(616) 975-5500

DON01 P-770

PATENT
DON01 P-770

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group Art	:	2878
Examiner	:	J. Lee
Applicants	:	Kenneth Schofield, Mark L. Larson and Keith J. Vadas
Serial No.	:	09/441,341
Filing Date	:	November 16, 1999
For	:	**VEHICLE HEADLIGHT CONTROL USING IMAGING SENSOR**

BOX NON-FEE AMENDMENT
Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The paragraph beginning at page 10, line 23, has been amended as follows:

-- In the illustrated embodiment, spectral filtering is carried out in a manner which exposes each photosensing element in the photosensor array to a band of light falling within one of the primary ranges of the visible spectrum, namely red, green, or blue as illustrated in Fig. 8a. However, different bands in the frequency spectrum may be utilized including not only visible spectrum bands but invisible spectrum bands including infrared and ultraviolet bands as illustrated in Fig. 8b. The band selection could also be chosen from visible spectral regions that do not correspond with the primary spectrums. For example, the spectral filter may be selected in order to detect at the pixel level red light sources and the ~~compliment~~ complement of red light sources as illustrated in Fig. 8c. These binary indications could be utilized to detect red taillights by determining that the "red" pixel is greater than a threshold and greater than a number of multiples of the intensity sensed by the "red ~~compliment~~complement" pixel adjacent thereto. Likewise, a white light source indicative of oncoming headlights could be detected by determining that both the "red" pixel and the "red ~~compliment~~complement" pixel adjacent thereto are both above a particular threshold and within a particular intensity range of each other. It may also be desirable to select bands that

fall between primary spectrum regions or any other bands that may be desirable for a particular application. --

IN THE CLAIMS:

Claims 54, 68, 69, 71-74, 77-79, 82, 84-86, 89, 91, 92 and 94-97 have been amended as follows:

54. (Amended) A control system for automatically controlling the state of the ~~head lamps~~ headlamps of a controlled vehicle, said control system comprising:

an optical system for imaging external sources of light within a predetermined field of view; and

an imaging processing system for processing images from said optical system and providing a control signal for controlling the state of the headlamps as a function of the ~~relative~~ output of pixels imaging the same spectral band of light.

68. (Amended) The control system as recited in Claim ~~67~~54, wherein said image processing system includes at least two photosensor arrays, and wherein said optical system comprises at least two lenses, one of said at least two ~~or more~~ lenses ~~and said array sensor are~~being configured to image ~~said predetermined field of view~~ onto ~~different portions of said image array sensor~~one of said at least two photosensor arrays, and the other of said at least two lenses being configured to image onto the other of said at least two photosensor arrays.

69. (Amended) The control system as recited in Claim 68, further including means for filtering the light through said at least two ~~or more~~ lenses such that one of said at least two ~~or more~~ lenses filters light below a first predetermined wavelength and another of said at least two ~~or more~~ lenses filters light above a second predetermined wavelength.

71. (Amended) The control system as recited in Claim 69, wherein one of said at least two ~~or more~~ lenses transmits light having a wavelength longer than 600 nm defining a red filter for imaging ~~tail lights~~ taillights on one ~~portion~~ of said at least two photosensor arrays~~image array sensor~~.

72. (Amended) The control system as recited in Claim 71, wherein tail lamps are detected by comparing the relative output of ~~a~~ at least one pixel imaged through the red filter with the ~~average pixel~~ output of a selected group of neighboring pixels ~~imaged through the red filter~~ and indicating a ~~tail lamp~~taillight detection when the ~~pixel~~ output of said at least one pixel imaged through the red filter is a predetermined percentage higher than the ~~average~~ pixel output of said selected group of neighboring pixels.

73. (Amended) The control system as recited in Claim 71, wherein ~~another one~~ the other of said at least two ~~or more~~ lenses transmits light having a wavelength shorter than 600 nm defining a cyan filter for imaging headlamps on ~~another portion~~ the other of said at least two photosensor arrays~~image array sensor~~.

74. (Amended) The control system as recited in Claim 73, wherein ~~head lamps~~headlamps are detected by comparing the relative output of ~~a~~ at least one pixel imaged through the cyan filter with the ~~average~~ output of a selected group of pixels and indicating a ~~head lamp~~ headlamp when the ~~pixel~~ output of said at least one pixel imaged through the cyan filter is a predetermined percentage higher than the ~~average pixel~~ output of said selected group of pixels.

77. (Amended) The control system as recited in Claim 76, wherein said image processing system includes means for detecting ~~tail lamps~~ taillights in each frame.

78. (Amended) The control system as recited in Claim 77, wherein said image processing system includes a dim counter, which is incremented, whenever a frame is processed which contains at least one ~~tail lamp~~ taillight or ~~head lamp~~ headlamp.

79. (Amended) The control system as recited in Claim 78, wherein said dim counter is reset whenever a frame containing no ~~head lamps~~ headlamps or ~~tail lamps~~ taillights is processed.

82. (Amended) The control system as recited in Claim 81, wherein said undim counter is reset when a ~~head lamp~~ headlamp or ~~tail lamp~~ taillight is detected in a frame.

84. (Amended) The control system as recited in Claim 54, wherein said control signal is used to turn the high beam ~~head lamps~~ headlamps completely on or completely off.

85. (Amended) The control system as recited in Claim 54, wherein said control signal is used to continuously vary the brightness level of said high beam ~~head lamps~~ headlamps between completely on and completely off.

86. (Amended) The control system as recited in Claim 85, wherein said control signal is used to vary the duty cycle of said ~~head lamps~~ headlamps.

89. (Amended) A control system for automatically controlling the state of the ~~head lamps~~ headlamps of a controlled vehicle, the control system comprising:

an optical system for imaging external sources of light within a predetermined field of view, the optical system including ~~an image array sensor~~at least two photosensor arrays and at least two ~~or more~~ lenses, each of said at least two lenses being configured to image said predetermined field of view onto a respective one of said at least two ~~or more corresponding portions of said~~ photosensor arrays ~~array~~; and

an image processing system for processing images from said optical system and providing a control signal for controlling the ~~head lamps~~ headlamps as a function of the relative output of the pixels imaging said external sources of light.

91. (Amended) The control system as recited in Claim 89, further including means for filtering the light through said at least two ~~or more~~ lenses.

92. (Amended) The control system as recited in Claim 91, wherein said filtering means includes a filter dye for said at least two ~~or more~~ lenses.

94. (Amended) A control system for automatically controlling the high beam state of the ~~head lamps~~ headlamps of a controlled vehicle comprising:

an optical system for imaging external sources of light within a predetermined field of view onto an image sensor containing a plurality of pixels, said optical system configured to

selectively transmit one or more predetermined spectral bands of light, and said optical system configured to image light within each predetermined spectral band onto ~~different predetermined blocks within~~ particular portions of said image sensor; and

an image processing system for processing images from said optical system and providing a control signal for controlling the high beam state of the ~~head lamps~~ headlamps as a function of the output of one or more pixels within ~~each~~ one of said portions ~~predetermined blocks,~~ relative to the output of other pixels within the same ~~block~~ portion.

95. (Amended) The control system as recited in Claim 94, wherein said image processing system provides a control signal for controlling the high beam state of the ~~head lamps~~ headlamps as a function of the output of pixels within one of said ~~predetermined blocks~~ portions relative to the output of pixels within another one of said ~~predetermined blocks~~ portions and where each of said pixels within one ~~block~~ portion images substantially the same region of space as a corresponding pixel within the other ~~block~~ portion.

96. (Amended) The control system recited in Claim 95, wherein ~~the~~ said optical system contains two or more ~~lenses, each lens having an associated filter~~ filters to transmit a predetermined spectral band of light and each ~~lens~~ filter being configured to image said field of view onto different designated ~~blocks~~ portions of said image sensor.

97. (Amended) The control system recited in Claim 96, wherein the optical system is configured to prevent light passing through one of said ~~lens~~ filters from arriving onto the ~~block~~ portion of the image sensor designated for light imaged by another of said two or more ~~lenses~~filters.